

How Integrated Room Controllers Reduce Office Energy Cost and Boost Worker Productivity

by Dusan Janjic

Executive summary

Office buildings waste up to 30% of the energy they consume. An upgrade from simple thermostats to networked integrated room controllers allows centralized control and monitoring of office energy use and environmental comfort. Such capabilities reduce energy costs and improve working conditions. This paper provides guidance for how room controllers can be networked to achieve a rapid return on investment (ROI) and continued long-term energy savings.

Introduction

It has been estimated that as much as 30% of the energy consumed by commercial office buildings is wasted.¹

Today commercial buildings often use simple thermostats to control their various rooms and offices. These are set according to schedules, allowing heating or air conditioning to be activated during the business day and turned down to predetermined set points during off-hours. Although meant to curb unnecessary energy use during off-hours, this approach does not account for dynamic office space use. Many offices and conference rooms are left unused during various periods of the day, as employees go to meetings, call in sick, or take days off.

Some office buildings control the heating and cooling centrally, not allowing for local adjustments in individual offices or common areas.

Either way, the problem is the same: HVAC and lighting systems operate whether offices are being used or not, with the building operating far from peak energy efficiency. Since up to 60% of a commercial building's energy use is consumed by HVAC systems, and up to 10% by lighting,² it's clear that significant energy is being wasted due to inefficient room controls.

A growing body of evidence is indicating that office worker productivity is closely tied to the temperature and overall environmental conditions of the building they occupy. The World Green Building Council states that "81% of workers find it difficult to concentrate if the office temperature is higher than the norm" and 62% "take up to 25% longer than usual to complete a task" if they are too hot.³

These problems can be addressed in both new and existing office buildings by replacing traditional thermostats with smart, integrated room controllers. These devices provide monitoring and control of individual rooms and improve overall building management. This paper analyzes the ROI of room controllers in terms of both reduced energy use and costs, and enhanced occupant comfort and performance.

Integrated room controllers can be thought of as more advanced, smart thermostats. Like thermostats, integrated room controllers can be easily programmed to maintain room temperature according to a schedule. However, room controllers go much further, incorporating a range of intelligent features that can directly reduce a building's energy costs.

These features can include:

- **Occupancy sensors** - Occupancy sensors use infrared, ultrasonic, or microwave technology to detect motion in a room, and then adjust the heating or air conditioning accordingly. Occupancy sensors override the standard settings of the room controller, based on actual room usage allowing for dynamic space control. Thus, if a worker is traveling for the day and the office is unused, the occupancy sensor will detect this and, after a certain length of time, revert to the appropriate, lower, set point.
- **Door/window sensors** - Some room controllers offer the ability to link to sensors that can detect when doors and windows are open, and then take appropriate action—such as sending an alert to a Building Management System, and/or turning the HVAC system off automatically. Also, these sensors can add security value to a

¹ EnergyStar (http://www.energystar.gov/ia/partners/publications/pubdocs/C+I_brochure.pdf?0b55-1475)

² "Reducing HVAC energy consumption," R. Hoffman, csemag.com, April 17, 2014

³ "Research Note: Thermal Comfort," World Green Building Council, 2003 (http://www.worldgbc.org/files/6714/1372/1194/140918_Research_note_-_Thermal_comfort.pdf)

What are integrated room controllers?

building (such as indicating a possible illegal entry), and they can be linked to video and access control systems for additional security benefits.

- **Lighting control** - Room controllers can be equipped to control lighting, as well as heating and air conditioning. This is accomplished through simple wiring connections that any certified electrician can install. With this capability, office lighting can be scheduled in the same way as temperature controls. Like HVAC, lighting can be controlled dynamically by an occupancy sensor so that lights are turned on and off based on actual use.
- **CO₂ ventilation control** - Room controllers can include CO₂ sensors (a requirement in many multi-purpose rooms and for newer building codes) with the ability to control ventilation fans. This allows for accurate control of the amount of fresh outside air that needs to be brought into the building, ensuring that CO₂ levels are within limits. Tempering outside fresh air is extremely costly compared to tempering recycled indoor air and using this kind of ventilation control can equate to massive savings in cold and hot weather climates. It improves indoor air quality while reducing energy costs and fan wear by running the fans only when required and only introducing the correct amount of outside air.
- **Wireless Communications** - Many room controllers are now available with wireless communications, which makes them easy and non-disruptive to install in existing buildings. This ease of installation can help cost-justify the retrofitting of most office buildings. Wireless communication also offers significant benefits when it comes to office space-planning and future reconfiguration. As the office utilization needs change there is often a need to redesign office interiors. Wireless room controllers are very well suited for this as there is no need for expensive rewiring of communication cables and/or containments.

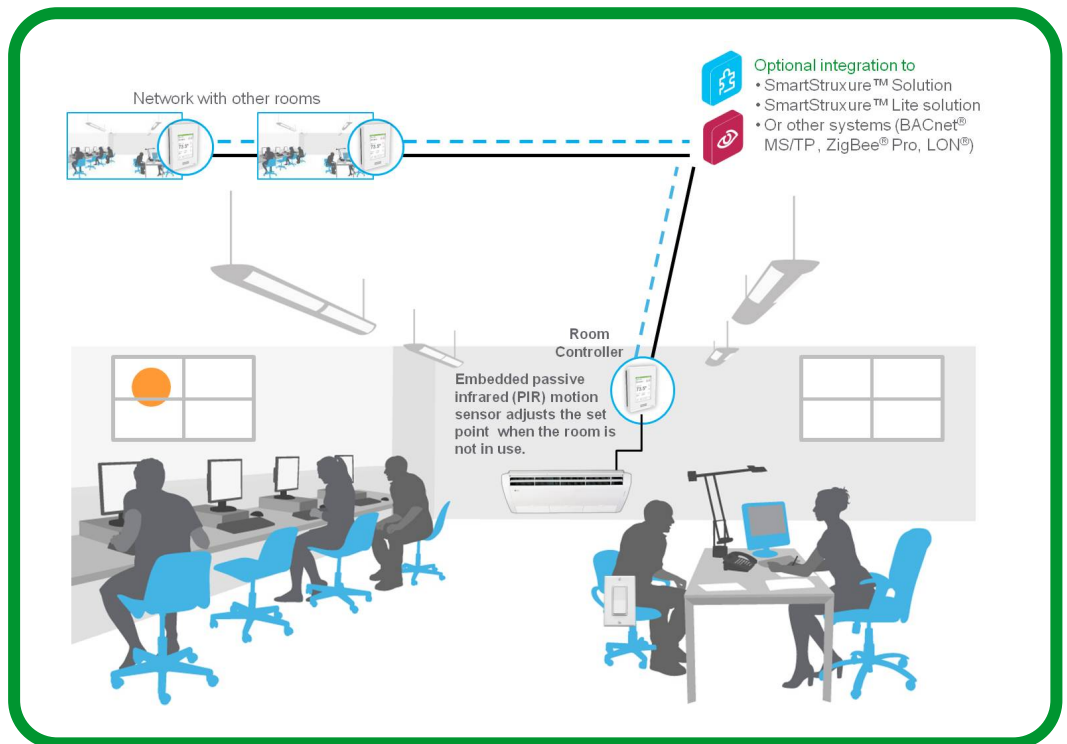


Figure 1
Room controllers allow for comfortable, low energy consumption office environments

Room controllers can be applied in many types of office buildings, from open floor plans to closed office spaces (see **Figure 1**). The savings and productivity gains will vary due to many factors. For example, offices where extremes in temperature are common will see large savings in heating and/or cooling costs. Buildings with a strong southern light exposure can adjust HVAC and lighting based on actual conditions rather than on a fixed schedule, taking advantage of natural heat and light to reduce energy use. While

The ROI of energy savings

specifics vary, most office buildings will benefit from improved energy control and management.

The most basic energy management approach is to deploy room controls as a standalone system, using presence detection sensors and door/window contact sensors. In a standalone system, devices exchange information inside the room but are not connected to other systems outside the room.

Even this basic approach can yield significant ROI in an office building. EnergyStar estimates that simply turning off lights when not needed—something that can be controlled automatically with occupancy sensors—can reduce lighting expenses by as much as 40 percent.⁴

Much greater savings and faster ROI can be achieved when the office systems are networked and integrated with a building management system (BMS), a software platform designed to provide integrated monitoring, control, and management of energy, lighting, fire safety and HVAC. A BMS provides facility managers with centralized control and promotes a facility-wide approach to managing energy and occupant comfort.

Using room controllers linked to a BMS provides additional ROI in the following ways:

Improved building management

A BMS can provide a wealth of information to help decision makers. Access to real-time data across systems greatly reduces the time it takes to diagnose and fix issues. It also provides new insights into how building systems work together, providing opportunities to improve and optimize overall operations. Integration makes it much easier to observe cross-system trends that indicate best practices or areas for improvement – something that is difficult to execute if all systems are managed on an individual basis.

The benefits of a BMS include the ability to:

- Validate performance and verify savings
- Implement future energy-saving measures and justify investments
- Display energy consumption, alarms, and trend comparisons
- Track business performance data
- Provide data on temperature history, people, locations

Deep setback for unused offices

Room controllers can adjust temperatures in unoccupied offices to save energy and money; however these savings are limited because temperatures must be maintained within a certain range to ensure optimal comfort when the occupant returns. With networking and centralized control, a building manager can easily adjust rooms to deep set-back or, in some cases, temporarily shut down rooms or areas to eliminate unnecessary expense. Deep set-back permits increased energy efficiency by reducing set points in heating and cooling seasons. The ability to adjust settings in this way can significantly impact ROI and reduce the initial payback period.

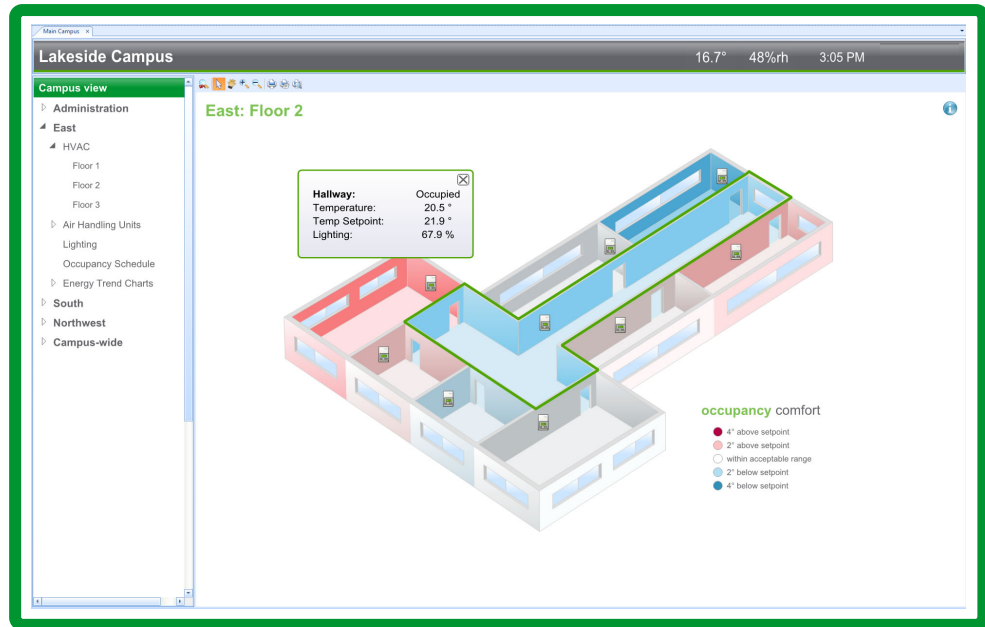
Decreased maintenance costs

Maintenance staffs often operate in a reactive mode, repairing equipment when it breaks or responding to specific complaints. When networked room controllers are linked to a BMS, maintenance staff is enabled to be proactive. Problems can often be resolved remotely (see **Figure 2**). Breakdowns can be prevented by recognizing performance problems and taking early action—at a lower cost than making emergency repairs and

⁴ EnergyStar (<http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/stamp-out-energy-waste>)

with a lot less disruption. Continuous monitoring of office space will result in higher occupant satisfaction and improved maintenance response time when problems do arise.

Figure 2
Monitoring of the office space environment will result in proactive energy management as well as a higher occupant satisfaction



Linking room controllers to a BMS can also enhance security. With occupancy detection, the system is able to alert personnel if an office or zone is occupied during unused periods. This safeguards company property inside an area, and assures management that only authorized personnel are permitted to enter when the area is vacant.

What the research reveals regarding energy savings

A study by the U.S. General Services Administration found that green buildings cost 19 percent less to maintain and use 25 percent less energy and water.⁵ In Schneider Electric’s experience, by networking room controllers and implementing the capabilities described above, office buildings are typically able to reduce energy costs by as much as 30% or more.⁶

A study appearing in Advanced Materials Research found even greater savings. In this case, an office building of 66,943 square feet in San Francisco was retrofitted with room controllers and a BMS. The study found that energy consumption was reduced by 50% for an annual savings of \$172,000 and a payback period of just 1.7 years.⁷

Of course every office building is different and the ROI will vary depending on factors such as location, size, building construction, and so on. However, nearly all office buildings should be able to achieve significant energy savings through the use of integrated room controllers, especially when linked to building management systems.

The ROI of worker productivity

Occupant comfort is always an important priority in office buildings, and many studies point to a strong link between worker comfort and worker productivity. The popular LEED

⁵ “Green Buildings Cost 25% Less to Operate,” Environmental Leader, Jan 2015 (www.environmentalleader.com)

⁶ Based on Schneider Electric customer experience. This is not a guarantee of future performance or performance in your particular circumstances.

⁷ “Effect of Building Management System on Energy Saving,” Kamali et al, Advanced Materials Research Vol. 856, 2014 (http://www.academia.edu/5365112/Effect_of_Building_Management_System_on_Energy_Saving)

rating system, which certifies buildings that meet certain energy saving requirements, has a specific credit called: "To promote occupants' productivity, comfort, and well-being by providing quality thermal comfort".⁸

Room controllers, especially when linked to a BMS, can improve occupant comfort and performance by:

- Enabling the BMS to send an alarm if a room is out of a certain threshold in use, allowing preventive maintenance before someone complains
- Providing the ability to change room parameters remotely to accommodate an occupant or tweak a room that has been "troublesome"
- Pre-cooling or pre-heating rooms to the "occupied" set point when people are returning—instead of waiting until the person enters his or her office
- Identifying when a door or window has been left open for a long period of time, especially in unoccupied rooms, so maintenance personnel can be dispatched

What the research reveals regarding worker productivity

One recent study conducted by the US General Services Administration concluded that green buildings had a 27 percent higher rate of occupant satisfaction.⁹ In another study, office workers were found to perform better at tasks such as typing, addition, reading comprehension and creative thinking in offices with "high performance building ventilation, thermal control, and lighting control environments."¹⁰

In a study conducted in banking offices, it was found that the difference between LEED certified and non-certified bank branches equals \$461,300 of additional revenue per employee.¹¹ While LEED certification represents a specific type of rating and denotes high energy efficiency, this study nevertheless indicates the substantial improvements in productivity that can be achieved by enhancing the office environment and the comfort of workers.

ASHRAE has aggregated a large sample of such studies that can be found on their website at: www.ashrae.org/File%20Library/docLib/Technology/FAQs2014/TC-02-01-FAQ-50.pdf. Such conclusive research is now convincing many corporations of the high impact of thermal comfort on employee productivity.

Considerations

Many room controllers are available on the market today, and they can be installed and supported by local building contractors. Keeping in mind the issues discussed in this paper, building owners will want to choose products and providers that offer:

Feature options - Occupancy sensors, door sensors, and other capabilities can help maximize return on investment. All of these capabilities may not be required at once, but it is prudent to plan for simple integration in the future.

Wireless communications - Room controllers can be networked with either wired systems (more commonly used in new construction) or wireless communications (often used in retrofits). The wireless option is important, since this usually simplifies installation and lowers the cost of retrofitting existing buildings.

⁸ <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=220>

⁹ "Green Buildings Cost 25% Less to Operate," Environmental Leader, Jan 2015 (www.environmentalleader.com)

¹⁰ "Greening America's Schools: Costs and benefits," G. Kats, Oct. 2006 (<http://www.usgbc.org/Docs/Archive/General/Docs2908.pdf>)

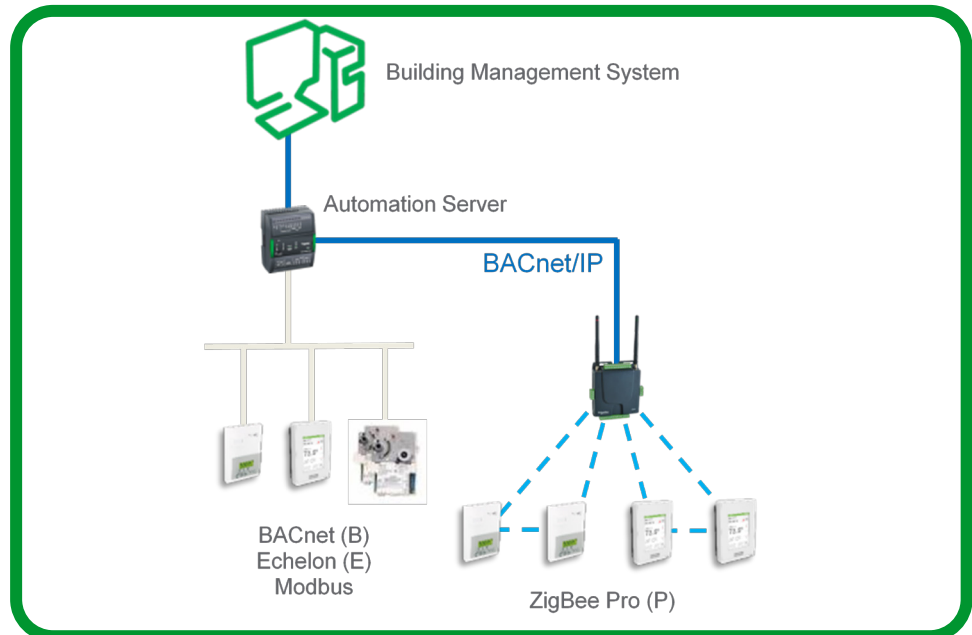
¹¹ "Research Shows That LEED-Certified Bank Branches Have Greater Revenues," R. Godelnik, Triple Pundit, Oct 2012 (www.triplepundit.com/2012/10/another-reason-banks-consider-lead-certification-branches-greater-revenues/)

Simple networking through open protocols - Room controllers and building management systems communicate with each other using industry-standard protocols. There are several standards in use, the most common of which are:

- Wireless: ZigBee and EnOcean
- Wired: BACnet and LonWorks

Figure 3

Simple diagram showing how wired and wireless systems can co-exist in a single ecosystem



A detailed discussion of standards is beyond the scope of this paper; however available standards should be discussed with your vendor to ensure that the products installed today will be able to communicate with those planned for the future. In addition, adherence to standards allows for vendor independence in your design approach

Easy scalability - Select a solution that can be scaled to a full BMS, linked to other buildings, and integrated with other systems such as power management and security. This will help future-proof your investment and ensure continued ROI over the years.

Leverage available funding options - To encourage property owners to reduce their carbon footprint and dependence on fossil fuels, many local, state, and federal governments offer incentive programs and funding packages for the installation of renewable and energy-efficient technologies such as energy management systems. Additionally, many incentive plans are available from local utility companies for sustainable installations. This often comes in the form of product rebates on a per-unit basis or preferential low-interest loans. Further information on state, local, utility and federal incentives and policies in the United States can be found at www.DsireUSA.org.

Conclusion

Office buildings waste as much as 30% of the energy they consume, in large part because HVAC and lighting systems operate whether offices are being used or not. By upgrading from simple thermostats to integrated room controllers, building owners can eliminate most of that waste, resulting in improved energy efficiency, lower costs, and greater occupant comfort and productivity.

Wireless room controllers can offer a quicker ROI and the possibility of taking immediate advantage of these benefits with minimal interruption to day-to-day business in existing buildings.

For building owners and managers who want to learn more about these issues, www.energystar.gov (created by the Environmental Protection Agency) is an excellent source of information. An overview of energy saving measures can be found at <http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/stamp-out-energy-waste>. The U.S. Department of Energy at www.energy.gov is also a rich source of information.

In Europe, the European Commission at <http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings> is a good source of general information. Financing help for energy renovations is available at <http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings/financing-renovations>.

Your local building contractor or systems integrator can provide options on products and services, and should be able to provide a projection of the ROI that will result from specific energy control upgrades.

Every building is different, but by choosing vendors and products carefully, networking room controllers to maximize energy savings, and taking advantage of special funding for energy improvements, building owners and managers should be able to achieve their energy reduction goals with a full return on investment in a few years, or possibly even within months.



About the author

Dusan Janjic is Buildings Offer and Solution Manager for Schneider Electric, based in France. He specializes in building automation and has been a project engineer, project manager, technical support and training manager, and business development manager for the company. A member of IEEE and the BACnet Association of France where he previously served as Vice President, he holds degrees in computer engineering and business administration from McGill University in Montreal, Canada.